CLAIMS

1. A method for laser processing a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate, comprising:

providing slow and fast movement-controlling signals from a positioning signal processor;

controlling with a slow positioner driver a large range of relative movement of a translation stage in response to the slow movement-controlling signal;

controlling with a fast positioner driver a small range of relative movement of a fast positioner in response to the fast movement-controlling signal;

generating first laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the first laser system output at a target location on the substrate to ablate substrate material at the target location with a first spot area of less than 25 μm on the surface of the target material;

generating second laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the second laser output to impinge a second target location with a second spot area of less than 25 μm on the surface of the target material such that the second spot area at least partly overlaps the first spot area.

2. A method for laser processing a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate, comprising:

generating first laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the first laser system output at a target location on the substrate to ablate substrate material at the target location with a first spot area of less than 25 μm on the surface of the target material;

generating second laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the second laser output to impinge a second target location with a second spot area of less than 25 μm on the surface of the target material such that the second spot area at least partly overlaps the first spot area to form a through hole through

the substrate, substrate being at least 50 μm thick and the through hole having an aspect ratio of greater than about 20:1.

3. The method of claim 2 in which the laser system output comprises at least 5 laser system output pulses.

4. The method of claim 2 in which the substrate is impinged on its front surface and the through hole penetrates its back surface, the method further comprising:

employing characteristics of the through hole on the back surface for aligning a device to perform a process on the back surface of the substrate.

5. The method of claim 4 in which at least two through holes are formed and both through holes are employed to align the back surface of the substrate for further processing.

6. The method of claim 2 in which the substrate is impinged on its front surface and the through hole penetrates its back surface, and in which the substrate is supported by a chuck having a surface material that is substantially nonreflective to the laser system outputs.

7. The method of claim 6 in which the surface material of the chuck substantially inhibits laser damage to the back surface of substrate.

8. The method of claim 6 in which the surface material of the chuck is substantially transparent to the laser system outputs.

9. The method of claim 6 in which the surface material of the chuck is substantially absorbing to the wavelength of the laser system outputs.

10. The method of claim 2 in which the substrate is impinged on its front surface and the through hole penetrates its back surface, and in which the substrate is supported by a chuck having a surface material has openings over which through hole processing occurs.

11. A method for laser processing a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate, comprising:

generating first laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the first laser system output at a target location on the substrate to ablate substrate material at the target location with a first spot area of less than 25 μm on the surface of the target material;

generating second laser system output at a wavelength shorter than 400 nm and having an output pulse energy of greater than 200 μJ;

directing the second laser output to impinge a second target location with a second spot area of less than 25 μm on the surface of the target material such that the second spot area at least partly overlaps the first spot area to form a kerf having a lengthwise dimension greater than the spot size.

12. The method of claim 11 in which characteristics of the laser outputs inhibit formation of a melt lip.

13. The method of claim 11 in which characteristics of the laser outputs inhibit slag formation.

14. The method of claim 11 in which characteristics of the laser outputs inhibit peel back of the kerf edge.

15. The method of claim 11 further comprising:

generating successive laser system outputs at a wavelength shorter than 400 nm and having output pulse energies of greater than 200 μJ;

directing the successive laser outputs to impinge successive target locations with spot areas of less than 25 μm on the surface of the target material such that the successive spot areas at least partly overlap respective preceding spot areas to form the kerf.

16. The method of claim 11 in which the kerf comprises a curvilinear profile.

17. The method of claim 11 further comprising:

providing slow and fast movement-controlling signals from a positioning signal processor;

controlling with a slow positioner driver a large range of relative movement of a translation stage in response to the slow movement-controlling signal;

controlling with a fast positioner driver a small range of relative movement of a fast positioner in response to the fast movement-controlling signal to effect the curvilinear profile of the kerf.

18. The method of claim 11 in which the substrate has deep kerfs with bottoms, and the deep kerfs separate devices but retain sufficient thickness of substrate at the bottom of the deep kerfs to connect the devices, further comprising employing the laser system outputs to separate the devices.

19. The method of claim 11 in which the substrate is supported by a chuck having a surface material that is substantially nonreflective to the laser system outputs.

20. The method of claim 19 in which the surface material of the chuck substantially inhibits laser damage to the back surface of substrate.

21. The method of claim 19 in which the surface material of the chuck is substantially transparent to the laser system outputs.

22. The method of claim 19 in which the surface material of the chuck is substantially absorbing to the wavelength of the laser system outputs.

23. The method of claim 11 in which the substrate has a substrate depth and the kerf extends through the substrate depth, and in which the chuck has openings over which through kerf processing occurs.

24. A method for increasing the throughput of severing a workpiece having a substrate material depth of at least 300 μm and comprising a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate, comprising:

identifying a first feature on a first surface of the workpiece;

aligning with respect to the first feature on the first surface a first target position of a laser system such that the first target position is on the first surface and in proximity to an intended side of a component of the workpiece;

directing one or more first laser outputs to impinge the first surface at the first target position and linearly therewith to form a first kerf to a kerf depth that is less than the material depth;

aligning with respect to a second feature on the first surface or on a second surface a second target position of the laser system such that the second target position is on a second surface and in proximity to the intended side of the component and in the same plane as the first target position; and

directing one or more second laser outputs to impinge the second surface at the second target position and linearly therewith to form a second kerf in the same plane as the first kerf to form a throughcut that defines the intended side of the component.

25. The method of claim 24 in which first and second features comprise respective through holes laser drilled through the material depth and apparent on both the first and second surfaces.

26. The method of claim 24 in which the substrate is supported by a chuck having a surface material that is substantially nonreflective to the laser system outputs.

27. The method of claim 24 in which the surface material of the chuck substantially inhibits laser damage to the back surface of substrate.

28. The method of claim 24 in which the surface material of the chuck is substantially transparent to the laser system outputs.

29. The method of claim 24 in which the surface material of the chuck is substantially absorbing to the wavelength of the laser system outputs.

30. The method of claim 24 in which the chuck has an opening over which through hole processing occurs.

31. A method for laser processing a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate of a workpiece having first and second surfaces, comprising:

providing slow and fast movement-controlling signals from a positioning signal processor;

controlling with a slow positioner driver a large range of relative movement of a translation stage in response to the slow movement-controlling signal, the translation stage comprising or supporting a chuck having a surface material that is substantially nonreflective to laser system outputs;

controlling with a fast positioner driver a small range of relative movement of a fast positioner in response to the fast movement-controlling signal;

generating successive laser system outputs at a wavelength shorter than 400 nm and having output pulse energies of greater than 200 μJ;

directing the successive laser outputs to impinge successive target locations with spot areas of less than 25 μm on a first surface of the workpiece such that the successive spot areas at least partly overlap respective preceding spot areas to form a through hole or through cut in the substrate without substantially damaging the second surface.

32. The method of claim 31 in which the surface material of the chuck is substantially transparent to the laser system outputs.

33. The method of claim 31 in which the surface material of the chuck is substantially absorbing to the wavelength of the laser system outputs.

34. A laser system for processing a silicon, GaAs, indium phosphide, or single crystalline sapphire substrate of a workpiece, comprising:

a slow positioner for effecting a large range of relative movement between the tool and the workpiece, the slow positioner including a translation stage comprising or supporting a chuck having a surface material that is substantially nonreflective to laser system outputs;

a fast positioner for effecting small ranges of relative movement between the laser system outputs and the workpiece;

a positioning signal processor for deriving from the positioning command slow and fast movement-controlling signals;

a slow positioner driver for controlling the large range of relative movement of the translation stage in response to the slow movement-controlling signal;

a fast positioner driver for controlling the small ranges of relative movement of the fast positioner in response to the fast movement-controlling signal; and

a resonator for generating the laser system outputs.

35. The laser system of claim 34 in which the surface material of the chuck is substantially transparent to the laser system outputs.

36. The laser system of claim 34 in which the surface material of the chuck is substantially absorbing to the wavelength of the laser system outputs.

37. The laser system of claim 34 in which the fast positioner driver facilitates production of a kerf with a curvilinear profile.